City of Norfolk, Virginia
Department of Utilities

Standard Design Criteria Manual

August 2003

City of Norfolk, Virginia
Department of Utilities

DESIGN CRITERIA

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INTRODUCTION

This Design Standards Manual has been developed for use by consultants and developers working on water and sewer utility projects within the City of Norfolk, Virginia. The standards are not intended as a regulation, but are to be used as a guide that will provide conformity to the design and review of public water and wastewater utility improvements that are to be owned and maintained by the City of Norfolk. *As it is very difficult to generalize engineering design matters without endangering the final product, consultants and developers shall design projects using the standards presented herein as a guide only. These Standards are not intended to replace sound engineering judgment. Designers should consider the applicability of the contents of this document to specific projects and, based on the characteristics and requirements of the projects, make adjustments accordingly.*

This manual replaces the earlier version of the Design Standards Manual. It is intended to be used with all applicable building, plumbing, and electrical codes; the current edition of the Hampton Roads Planning District Commission (HRPDC) Regional Standards; the current edition of the Virginia Department of Transportation Road and Bridge Specifications; the current edition of the Virginia Department of Health Sewerage Regulations and Waterworks Regulations; and the current edition of the Department's Standard Specifications and Details. All users of this guide should recognize the fact that all local, state and federal codes and regulations must be satisfied on all projects. In the event that these Standards differ from state or federal requirements, the more restrictive standard shall apply.

The sections of this manual identify routine or standard design assumptions and practices used and accepted by the Department, and are a compilation of widely accepted design practices and standards presently in use throughout the professional engineering and water and wastewater communities. Deviations from these Standards, and special or unique design situations should be thoroughly addressed in the Preliminary Design Report.

The Department strives for continuous improvement. Comments or suggestions for the improvement of this document are welcomed. Please send comments or suggestions to:

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City of Norfolk
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City of Norfolk, Virginia
Department of Utilities

REFERENCES
(Latest Editions)

ACI 211 - Guide for Submittal of Concrete Proportions
ACI 212 - Chemical Admixtures for Concrete
ACI 301 - Specifications for Structural Concrete
ACI 318 - Building Code Requirements for Structural Concrete
ACI 350 - Wastewater Facilities

American Railway Engineering Association Specifications

AWWA Manuals of Practice -
- # Sizing Water Services Lines & Meters (M22)
- # Water Meters - Selection, Installation, Testing and Maintenance (M6)
- # Distribution System Requirements for Fire Protection (M31)/ISO
- # Ductile-Iron Pipe and Fitting (M41)
- # Distribution Valves: Selection, Installation, Field Testing, and Maintenance (M44)

AWWA Standards

DIPRA –
- Thrust Restraint Design Manual
- Corrosion Protection
- Design of Ductile Iron Pipe
- Design of Ductile Iron Pipe Supports
- Truck Loads on Pipes

Hydraulic Institute - Engineering Data Book Standards

Insurance Services Office (ISO) Fire Suppression Rating Schedule

International Plumbing Code (IPC)

NASSCO –
- Wastewater Collection Systems Manual of Practices
- Inspector Handbook for Sewer Collection System Maintenance and Rehabilitation

NEC - National Electrical Code

NFPA - National Fire Protection Handbooks

Sanks, R. L. – "Pumping Station Design", Second Edition

Uni-Bell Plastic Pipe Association - Handbook of PVC Pipe

Unified Statewide Building Code

Virginia Department of Health
Sewerage Regulations
Waterworks Regulations

Water Environment Federation (WEF) -
Design of Wastewater and Stormwater Pumping Stations (MOP FD-4)
Gravity Sanitary Sewer Design and Construction (MOP FD-5)

City of Norfolk, Virginia
Department of Utilities

DESIGN CRITERIA
SECTION 1 – SEWAGE PUMPING STATIONS

1.1 General Requirements

These general criteria are to be used as the minimum standards for the design of sewage pumping stations. The design of sewage pumping stations is an engineering matter and is not subject to detailed recommendations or requirements other than as required by these Standards. Each pumping station is to be designed for the site-specific conditions and restraints and shall take into account current as well as future development in the service area. A detailed Preliminary Engineering Report shall be submitted by the Design Engineer to the City for approval prior to design. The report shall fully comply with all the requirements listed herein as well as applicable Virginia Department of Health (VDH) requirements. This report shall contain a Master Utility Plan and all future phasing of the project. The report shall evaluate the entire proposed sanitary sewer area, and shall evaluate overall effect on downstream City and Hampton Roads Sanitation District (HRSD) facilities. Any variations from these standards shall be specifically noted in the design and is subject to approval by the Department of Utilities (Department).

Sewage pumping stations are to be provided solely for the conveyance of sanitary wastes. Under no circumstances shall any form of storm drainage be allowed to pass through the proposed facility.

In addition to the Standards herein, the design must conform to the minimum standards set forth in the Virginia Department of Health Sewerage Regulations, the BOCA National Building Code, and by the Virginia Department of Environmental Quality. The Design Engineer shall submit the Preliminary Engineering Report and the design drawings and specifications with design calculations to VDH in accordance with the requirements of the "Sewerage Regulations." Additionally, a complete set of signed and sealed design calculations in accordance with VDH requirements shall be included as a part of the Operation and Maintenance Manual that is submitted to the City and to VDH prior to start-up of the pumping station. The designer shall coordinate with VDH on the latest Operation and Maintenance manual submittal requirements.

Appendix A contains the general City of Norfolk Commercial Plan Review Checklist that is used by the Department's Permits and Plan Review Division. The Design Engineer is cautioned that this is not a comprehensive checklist and may vary with each project.

All applicable federal, state, and local permits and approvals must be obtained prior to plan approval. This includes the requirement to formally obtain a construction permit through the Virginia Department of Health and the Virginia Department of

Environmental Quality. If a waiver for formal permit issuance has been granted, proof of the waiver must be presented prior to plan approval.

1.2 Technical Design

1.2.01 System Layout

1.2.01.1 Sewage pumping stations should be located as far as practicable from present or proposed built-up residential areas. A buffer zone of at least 100 feet shall be provided when possible. If not possible, the buffer zone may be 50 feet provided an artificial buffer is constructed. An artificial buffer can be landscaping, security fence, or other buffer as approved by the Department. VDH requirements must be met for stations designed for use in an existing development.

1.2.01.2 An ample, all-weather road, including asphalt paving, storm drainage and parking, shall be provided for easy access to the pumping station by Department maintenance vehicles, vacuum trucks, and lifting equipment sized to remove and replace the largest piece of equipment in the station. The Design Engineer shall consult with the Department for information on the vehicles and equipment in the Department fleet.

1.2.01.3 All mechanical and electrical equipment which could be damaged or inactivated by contact with or submergence in water (motors, control equipment, blowers, switch gear, bearings, etc.) shall be physically located one foot above the 100-year flood/wave action or otherwise protected against the l00-year flood/wave action damage. All stations shall be designed to remain fully operational during the 25-year flood/wave action.

1.2.02 Class I Reliability

1.2.02.1 Reliability provisions are based on a measurement of the ability of a component or system to perform its designated function without failure or interruption of service. Overflow criteria, such as a period of discharge, are utilized solely for the establishment of reliability classification for design purposes and are not to be construed as authorization for, or defense of, an unpermitted discharge to state waters. Sewage pumping stations shall meet Class I Reliability as defined in the "Sewerage Regulations." At a minimum, a station meeting the criteria of Class I Reliability must monitor and record the main power supply, auxiliary power supply, failure of each pump to discharge, high liquid level in wet/dry wells; and be equipped with a test function and a back-up power supply. Additionally, Class I Reliability may be attained if the station wet well and collection system have the required excess storage capacity to prevent sewage overflows.

1.2.02.2 Emergency Standby Power Generator – The station will be provided with an emergency power supply in the event of a power failure unless otherwise approved by the Department. The complete standby electric system will consist of an engine driven generator set, an automatic load transfer switch, time switches, contactors, wiring, conduit, piping and accessories. The standby power generator shall be designed for the following parameters:

A. Standby power generator shall be sized to run the entire station at full load for a minimum of 48 hours.

B. Where readily available and feasible, natural gas powered equipment shall be used. Where natural gas is not feasible, diesel powered equipment shall be used. Gasoline powered engines will not be accepted.

C. Where a fuel tank is required, the tank shall be above ground with appropriate double wall construction and proper containment. The containment structure shall have no drains in order to contain any spills that may occur.

D. Locate the generator inside the pumping station. The generator shall be housed in a separate room with appropriate exhaust ventilation. Access shall be designed such that the generator can be removed through a door, through a removable roof section, or other method approved by the Department.

E. A weekly generator testing interlock with the pumping station SCADA system shall be provided.

1.2.02.3 At the discretion of the Department, smaller pumping stations may be designed without standby power. For these smaller pumping stations, the wetwell shall be designed with an emergency storage volume (between high water alarm and potential overflow) that provides for a two-hour response time under average flow conditions or as approved by the Department. Additionally, these stations shall be designed with the bypass pumping requirements specified in paragraph 1.2.06.K.

1.2.03 Capacity Design

1.2.03.1 Capacity design for the collection system discharging to the pumping station shall be as indicated in Section 2, Collection Systems and is based on the following:

A. Design of carrying capacities of lateral, trunk, and interceptor sewers shall be based upon the total sewer shed area served by the line. Consideration shall be given to the degree of present and future

development. Therefore, design flows shall be based upon a population estimate for the area to be served.

B. Equivalent flows from motels, schools, hospitals, etc., shall be based on the VDH Sewerage Regulations.

C. In the absence of the above information, the Design Engineer shall submit sufficient information substantiated by sound engineering judgment for approval.

1.2.03.2 The minimum, average and peak hourly station inflows shall be determined. Appropriate industry standard engineering methods, subject to approval by the Department, may be used in calculating the average sewage flows, which are determined from the type of buildings or area that the pumping station will service. The peak flow shall be determined by multiplying the average flow by 2.5.

1.2.03.3 Calculations must include detailed pumping station plans that clearly depict proposed pumping station, inlet sanitary sewer(s), number of services discharging to the pumping station and the discharge force main up to its discharge point. Static head, lengths of pipe, and approximate type and number of pipe fittings must be clearly marked.

1.2.04 Pumps and Pump Sizing Analysis

1.2.04.1 At least two pumping units shall be provided. Where two units are provided, each unit shall be capable of handling flows in excess of the expected peak flow as defined in paragraph 1.2.03.2. Where three or more units are provided, they shall be designed to have such capacity that, with the largest unit out of service, the remaining units will have capacity to handle the peak flow as defined in paragraph 1.2.03.2. The capacity of the pumping station with the largest pump out of service or on standby is also known as firm pumping capacity. When the station is expected to operate at a flow rate less than one-half times the average design flow for an extended period of time, the design shall address measures taken to prevent septicity due to long holding times of untreated sewage in the wet well.

1.2.04.2 The Department prefers to achieve firm station pumping capacity with two pumps installed in the station, whenever feasible. However, it may be more cost effective and beneficial to equip a station with three or more pumps. In general, two pumps should be used if the size of the pump motors are less than 50 hp. If over 50 hp, the Design Engineer shall perform a cost benefit analysis of three or more pumps in order to determine the most economical option for consideration by the Department.

1.2.04.3 The pump sizing shall be determined from a system pipe friction loss analysis of the pumping station piping and force main to its discharge point. Appropriate industry standard engineering methods, subject to approval by the Department, may be used to calculate pipe friction loss. All formulas, constants and assumptions must be clearly explained in the calculation. If using the Hazen-Williams formula, the C value for ductile iron pipe shall be 110; for PVC and HDPE piping the C value shall be 120. Losses shall include, at a minimum, pump suction and discharge minor type losses for piping, valves and fittings, plus static head.

1.2.04.4 Electric pump motors shall be designed and provided with reduced voltage motor starters.

1.2.04.5 The system curve shall be determined and transposed to a manufacturer's pump performance curve. The assumed operating point shall be indicated, along with the appropriate motor size, impeller size, Net Positive Suction Head (NPSH) capability and motor speed. The maximum one pump operation capacity, minimum operation head, maximum NPSH requirements and maximum motor loading shall also be indicated on the pump curves. Although the system curve does not need to be included on the construction contract drawings, the system curve shall be included in the Operations and Maintenance Manual turned over to the Department at the completion of the project.

1.2.04.6 Hydraulic transient control systems shall be evaluated including controlled discharge pump discharge valves, surge relief valves and force main air/vacuum valve systems.

1.2.04.7 Submit NPSH calculations for all pumping units for the maximum flow condition. The NPSH required by the pump under the maximum flow condition should not exceed 85% of the available NPSH.

1.2.04.8 Pumps handling raw sewage shall be preceded by readily accessible bar racks with clear openings not exceeding 2-1/2 inches. Bar racks shall be provided with by-pass weir and channel. Screens located below ground shall be provided with convenient facilities for handling screenings. For the larger stations (4.0 mgd and above), provide duplicate bar racks capable of handling the entire station flow.

1.2.04.9 Pumps in which the solids pass through the impeller(s) shall be capable of passing spheres of at least three inches in diameter. Pumping equipment having integral screens for preventing solids from passing through the impeller shall be capable of passing spheres of at least two inches in diameter.

1.2.04.10 Suitable shut-off valves shall be placed on each suction and each discharge line of each pump for normal pump isolation. A check valve is to be placed on each discharge line, between the shut-off valve and the pump. No shut-off valve shall be placed on the suction side of submersible pumps. Periodic exercising of valves should be specified within the routine maintenance programs.

1.2.04.11 Operating Sequence. At a preset point during a rise in wet well level, the first pump (the lead pump) shall be started, and it shall run as long as necessary to pump out the wet well to a low level pump cut off point. If the level continues to rise, the second pump (the lag pump) shall be started, and the two pumps then on line shall operate in parallel as long as necessary to pump out the wet well to the cut off point. This procedure continues for stations with three or more pumps. The automatic alternating control circuitry shall switch the operating sequence of the pumps (i.e. pumps alternate as lead pump) at each instance when all pumps are stopped. Provide a manual selector switch which shall allow manual selection of pump sequence or automatic alternation.

1.2.05 Structural Design

1.2.05.1 The station shall be designed to meet all applicable building codes. The building shall be structurally sound and designed for existing geotechnical conditions.

1.2.05.2 The station shall be designed with a lifting system (bridge cranes, overhead rails with hoists, etc.) that enables the heaviest equipment (typically the pump and motor assembly) to be lifted and removed from the building and loaded onto a vehicle in one lift. This can be accomplished by extending a structural beam through the access doors, removable roof, etc. The lifting system should be designed such that the heaviest equipment to be lifted does not exceed 75% of the system lifting capability. The Design Engineer shall consult with the Department to determine the most appropriate lifting and removal system for the existing site conditions and the available Department equipment. Lifting instructions and calculations shall be included in the final Operations and Maintenance Manual.

1.2.05.3 The effect of hydraulic thrust must be calculated by the Design Engineer and countered by the use of joint restraints, pipe anchorage, or other suitable means to prevent movement of pumping equipment and pipelines within the station. Submit calculations to the Department.

1.2.05.4 The use of flat station roofs is not acceptable.

1.2.06 Pump and Pump Room Requirements

1.2.06.1 The pump room shall be sized for ease of maintenance. A minimum of three (3) feet shall be provided from major pieces of equipment to the next piece of equipment, pipe or structure element.

1.2.06.2 Access and handling facilities shall be designed to facilitate removal and reinstallation of pumps.

1.2.06.3 The below grade portion of the pump room shall conform with the following:

A. Sump pump: The pump discharge is to be located above the wet well high water elevation and discharge into the wet well.

B. Pumps shall be installed on raised pads.

C. Electrical outlets are to be installed three (3) feet or higher above the floor slab elevation. Installation shall include NEMA Type "4 X" enclosures.

D. All lights are to be accessible from both the bottom slab and/or the stairs.

E. Switches to de-energize each motor with a lockout button shall be provided in a NEMA Type "4 X" enclosure.

F. A dry-pit submersible pump installation shall be used for all dry-pit type pumping stations.

G. Wet-pit, submersible pump type stations shall only be used when the station capacity does not exceed 50 gpm. Wet-pit type stations shall be provided with an outdoor control panel with stainless steel enclosures.

H. Suction-lift type, wet-pit pumping stations are not acceptable.

I. All valve operators shall be accessible from the pump room floor or stair landing. Chain wheel operators are not acceptable without prior approval from the Department.

J. The pump discharge piping shall not connect to the bottom of the discharge header.

K. Provide all pumping stations with station by-pass piping and valves including 8" by-pass pump suction piping from the wet well and 8" by-pass connection from the force main complete with valve and cap.

Provide stations with a spare power feeder breaker and automatic controls for by-pass pumping operation. Provide a lockable access opening through the station exterior wall to run the power and control cables out to the by-pass pumping unit.

L. The pumping station shall also contain restroom facilities and a washdown hose bib for Department personnel. Appropriate backflow prevention devices shall be installed on potable water supply lines per applicable City codes.

1.2.07 Ventilation

1.2.07.1 Ventilation shall be provided for the building and the wetwell in accordance with NFPA code 820, the VDH Sewerage Regulations, and VOSH requirements and shall comply with this section for enclosed spaces within pumping stations during all periods when the station is manned. Where the pump is permanently mounted below the ground, mechanical ventilation is required and shall be arranged so as to independently ventilate the dry well.

1.2.07.2 The building shall be provided with adequate outside air ventilation to maintain a maximum internal station temperature of 40° C (104° F) based on an outside air temperature of 35° C (95° F).

1.2.07.3 Ventilation using outside air is generally acceptable to dissipate motor heat. In stations with VFD's where heat buildup may be a problem, calculations shall be performed for the outside air ventilation system to dissipate the maximum heat load (all pumps and VFD's operating) while maintaining a maximum air temperature of 40°C (104°F) based on an outside air temperature of 35°C (95°F).

1.2.07.4 At a minimum, ventilation of the wet well shall be accomplished by the provision of a properly screened vent, with the end either turned downward or provided with a "mushroom" cap. The vent shall be at least four inches in diameter. If screens or mechanical equipment, which might require periodic maintenance and inspection, are located in the wet well, then maintenance personnel shall mechanically ventilate it at the time of access.

1.2.07.5 There shall be no interconnection between the wet well exhaust flow and the dry well ventilation systems. In pits over 15 feet deep, multiple inlets and outlets shall be provided. Dampers shall not be used on exhaust or fresh air ducts, and fine screens or other obstructions in air ducts shall be avoided to prevent clogging. Automatic heating equipment shall be provided in all stations where necessary.

1.2.07.6 Switches for operation of ventilation equipment shall be marked and conveniently located above grade and near the pumping station entrance.

Consideration should be given also to automatic controls where intermittent operation is used. The fan drive shall be fabricated from non-sparking material in accordance with applicable codes and standards.

1.2.07.7 Ventilation shall be intermittent with at least 30 complete air changes per hour. Such ventilation shall be accomplished by mechanical means.

1.2.07.8 All ventilating equipment shall be corrosion resistant and of non-sparking construction.

1.2.07.9 The station controls system shall include a control feature that shuts off all ventilation equipment when there is a high water alarm in the wetwell. This feature is to prevent wastewater from entering the ventilation intake.

1.2.08 Wet Well Requirements

1.2.08.1 The effective capacity of the wet well should be such that one pump will run continuously at least five (5) minutes during a thirty (30) minute period of minimum flow at design flow conditions and there will be no more than five (5) pump starts per pump in one hour.

1.2.08.2 Provisions shall be made to prevent solids deposition. Where used, wet well fillets shall have a minimum slope of one-to-one. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the inlet.

1.2.08.3 In order to eliminate air entrainment, the wet well shall be designed so that influent wastewater does not free-fall into the wet well under normal operating conditions. In larger stations it may be necessary to consider vortex pipe inlets to minimize the introduction of air.

1.2.08.4 A corrosion resistant coating shall be installed on the interior of the wet well. The Department shall be consulted on suitable wet well coatings.

1.2.08.5 A gate valve located in a valve vault outside of the pumping station wet well shall be installed on all pumping station inlet gravity sewer lines.

1.2.08.6 All interior metal work shall be of Type 316L stainless steel.

1.2.08.7 All electrical fixtures in the wet well are to be explosion proof and located in serviceable locations. Interior electrical conduit shall be rigid metal conduit. All conduits shall be non-corrosive. Seals shall be installed in the conduit to prevent gases from traveling to the panel box.

1.2.08.8 A suitable and safe means of access shall be provided to the wet well. Wet well hatches shall be flush with floor and have a keyed recessed locking

mechanism. All hatch hardware shall be of Type 316L stainless steel material. The access must be designed to facilitate personnel hoist equipment. There shall be no obstructions in the hatch opening that would impede the hoisting equipment. Stairways shall be installed with rest landings at vertical intervals that do not exceed ten (10) feet. Stair treads shall be of a non-slip type and a minimum width of thirty-six (36) inches. Spiral ladders or staircases are not acceptable.

1.2.09 Motor Control Room Requirements

1.2.09.1 Motor control room structure:

A. Shall be constructed of brick or masonry block with brick veneer and placed on a concrete slab.

B. Shall not have windows.

C. Access to the control room shall be of sufficient size to allow the removal of installed equipment.

1.2.09.2 Underground stations may not require a separate motor control room structure but do require a secure exterior cabinet.

1.2.09.3 Motors shall be mounted on concrete pads secured with dowels to the floor slab.

1.2.09.4 Motors shall be three (3) phase sixty (60) cycle (220, 240 or 480 voltage) unless specifically approved otherwise. Stations that use three (3) phase motors shall be provided with one spare pumping unit (pump and motor) for each size provided. Where three-phase is not available, single-phase motors are acceptable with prior Department approval. Two additional spare pumping units (pump and motor) and spare capacitors shall be provided with each station containing single-phase motors.

1.2.10 Controls and Alarms

1.2.10.1 Pump Control and SCADA Telemetry shall be through a Programmable Logic Controller as specified by the Department. Telemetry shall be to the Department's SCADA Control Center with equipment compatible with existing hardware and software.

1.2.10.2 For the purpose of designating liquid levels for alarm requirements, high liquid level in the wet well is defined as a level of sewage in the wet well above normal operating levels such that either: (i) a backup of sewage in the incoming sewer may occur, or (ii) an overflow may occur, or (iii) standby pump(s) may be required to be activated. In the case of a duplex pumping

station with limited wet well volume, the alarm design should include activation at the time of simultaneous operation of both pumps, initiating when the second alternating pump starts (referred to as the lag pump). A low water level alarm shall also be included for all stations. The low water level alarm indicates a condition where the pumps do not shut off at the designated level for whatever reason.

1.2.11 Electrical Requirements

1.2.11.1 Station electrical and control wiring must meet City code and National Electric Code. Each station shall contain a main disconnect. All electrical equipment and components shall be UL listed unless otherwise specified.

1.2.11.2 The Design Engineer shall determine the availability of electrical service and coordinate the available electrical service with that required for the facility. The Design Engineer shall also determine the need for primary service extension and advise the City if an extension is necessary.

1.2.11.3 Electrical equipment and wiring shall be insulated and properly grounded. Switches and control shall be of the non-sparking type.

1.2.11.4 Adequate lighting shall be provided in all locations including: outside, motor control room, dry well, and wet well or any other area deemed necessary. The interior lighting shall be shielded.

1.2.11.5 Electrical equipment in enclosed places where gas may accumulate shall comply with the NEMA Class I, Div. 1, Group D specifications for hazardous conditions.

1.2.11.6 Pumping stations shall be equipped with a secure external disconnect switch located above grade.

1.2.12 Water Supply

1.2.12.1 There shall be no cross connection between any potable water supply and a sewage pumping station which under any conditions might cause contamination of the potable water supply. Potable water supply brought to the station shall comply with conditions stipulated in the Virginia Waterworks Regulations. Where conditions do not warrant the installation of an approved reduced pressure zone backflow prevention device on the water supply line to the pumping stations, other approved devices may be considered on a case-by-case basis.

1.2.13 Pumping Station Appurtenances

1.2.13.1 All pumping stations shall have reliable flow-measuring (mag meter or substitute approved by the Department) and pressure recording devices which are connected to the SCADA system for historical storage.

1.2.14 Other Requirements

1.2.14.1 The Design Engineer shall consider the need for protection of the pumping station against hydrogen sulfide and combustible gas and shall provide the proper equipment if such protection is found necessary.

1.2.14.2 Station security systems shall include door switches, wet well hatch switches, card reader systems, hardened station access systems, and other security systems as required and approved by the Department.

1.2.14.3 When discharging into the HRSD force main system, both minimum and maximum HRSD pressures shall be considered in the pump selection. The pumps shall operate efficiently without cavitation, under existing and proposed future head conditions. The installed pumps shall be capable, at a minimum, of conveying the average daily flow entering the station (at build-out) against future HRSD maximum head conditions. The pumps shall be provided with variable speed drives that allow the station to be operated over the full range of HRSD pressure conditions.

1.2.14.4 A device for measuring sewage flow shall be provided in pumping stations that discharge directly into the HRSD interceptor system. The device shall contain totalizers and daily recording charts, which measure flow in multiples of one thousand (1,000) gallons per day.

1.2.14.5 Pumping station sites shall be landscaped as required by the Norfolk Department of Parks and Forestry. The aesthetics of the station shall match the adjacent areas and are subject to review by the Design Review Committee.

1.2.14.6 The City of Norfolk standard "seal" shall be placed on all dry-pit type pumping stations at the primary station access door. The "seal" shall be installed on the outdoor control panel on all wet pit, submersible pump pumping stations.

City of Norfolk, Virginia
Department of Utilities

DESIGN CRITERIA
SECTION 2 – WASTEWATER COLLECTION SYSTEMS

2.1 General Requirements

Sanitary sewers are to be provided solely for the collection and transport of sanitary waste. Under no circumstances shall any roof drains, foundation drains, surface or subsurface drains be either directly or indirectly connected to sanitary sewers.

A detailed Preliminary Engineering Report shall be submitted to and approved by the Department prior to design. The report shall evaluate the proposed sanitary sewer service area, and shall evaluate overall effect on downstream City and HRSD facilities. The report shall fully comply with all the requirements listed herein as well as applicable Virginia Department of Health (VDH) requirements. This report shall contain a Master Utility Plan and all future phasing of the project.

All applicable federal, state, and local permits and approvals must be obtained prior to plan approval. This includes the requirement to formally obtain a construction permit through the Virginia Department of Health and the Virginia Department of Environmental Quality. If a waiver for formal permit issuance has been granted, proof of the waiver must be presented prior to plan approval.

2.2 Technical Design

2.2.01 Design Factors

A. Sewage collection systems shall be designed and constructed to achieve total containment of the predicted sewage flows contributed from the established service area and population.

B. In general, sewer systems shall be designed for the estimated ultimate tributary population with an upper limit consisting of the 50-year population growth projection, except in cases where capacities of system or parts thereof can be readily increased by future relief, allowing for shorter capacity design life of initial or subsequent lines. Consideration shall be given to land use plans and to other planning documents and to the maximum anticipated capacity of institutions, industrial parks, apartment developments, etc.

C. In determining the required capacities of sanitary sewers, the following factors shall be considered:

2.2.01.1 Average daily sewage flow

A. New sewer system capacity shall be designed on the basis of an average daily per capita flow of sewage of not less than that set forth in Table 2.1. When deviations from the foregoing per capita rates and established peak flow factors are proposed, a description of the procedure used to establish those design flows shall be included with the Preliminary Engineering Report.

TABLE 2.1

CONTRIBUTING SEWAGE FLOW ESTIMATES TO BE USED AS A DESIGN BASIS FOR NEW SEWAGE WORKS

Discharge facility	Contributing Design Units	Average Flow gpd	Flow duration, hours
Dwellings	Per person	100[(1)]	24
Schools w/showers and cafeteria	Per person	16	8
Schools w/o showers w/cafeteria	Per person	10	8
Boarding Schools	Per person	75	16
Motels @ 65 gal. per person (rooms only)	Per room	130	24
Restaurants	Per seat	50	16
Service Stations	Per vehicle serviced	10	16
Factories	Per person/per 8-hr. shift	15-35	Oper. Per.
Shopping Centers	Per 1,000 sf of ultimate floor space	200-300	12
Hospitals	Per bed	300	24
Nursing Homes	Per bed	200	24
Doctor's Offices in medical centers	Per 1000 square foot	500	12
Laundromats, 9-12 machines	Per machine	500	16
Community Colleges	Per student & faculty	15	12

Discharge facility	Contributing Design Units	Average Flow gpd	Flow duration, hours
Theaters (auditorium type)	Per seat	5	12
Picnic Areas	Per person	5	12

(1) Includes minimal infiltrations/inflow (I/I) allowance and minor contributions from small commercial/industrial establishments.

B. If not shown in the table above, industrial and commercial areas shall be calculated based on known building and staffing data or by the following formula:

A = acres
FD = Flow Duration (hours)
ADF = Average Daily Flow (gallons)

$$\frac{0.25 \times A \times 43560 \frac{sf}{acre} \times \frac{250 gpd}{1000 sf}}{FD \times \frac{1 day}{24 hrs}} = ADF$$

C. For special developments and unique facilities such as marinas, cruise ships, and barges, a detailed study to determine the average daily flow of sewage will be required. All design assumptions and documentation shall be provided to the Department for review.

2.2.01.2 Peak Sewage Flow

The design Peak Sewage Flow shall be determined using the chart in Appendix B. Any variations from this chart may be considered only with prior approval from the Department.

2.2.01.3 Population Density

Population density shall be in accordance with the Comprehensive Plan for the City of Norfolk projected by the Department of Planning and Codes Administration, or actual count or character of proposed development, whichever is greatest.

2.2.01.4 Ground Water Infiltration

Average daily flows discussed in 2.2.01.1 A., B., and C. include an allowance to carry unavoidable amounts of groundwater infiltration or seepage in addition to the sanitary flows. Collector and trunk sewers shall be designed to meet a maximum infiltration criterion of two hundred (200) gallons per day per inch diameter per mile of pipe.

2.2.02 System Layout

A. The overall layout and general design shall conform to the parameters set forth in the approved Preliminary Engineering Report.

B. Since all sanitary sewers must be accessible for operation and maintenance:

1. Where practical, locate all sanitary sewer in legally established road rights-of-way.

2. Where it is impossible to avoid placing public sewers on private property, the sewer shall be installed in legally established permanent easements for such purpose, either existing or new in accordance with these Standards.

3. Sewers shall be located outside of jurisdictional wetland areas, whenever possible. In the event that this is impractical, the Design Engineer must satisfy the Department that a permit from the US Army Corps of Engineers has been or is in the process of being obtained.

4. Stormwater BMPs shall not encroach on the sanitary sewer.

C. Construction shall be along the center line of rights-of-way or easements except when this location has been previously used by another utility, or when the width of a road right-of-way justifies the use of two sewer lines. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location.

D. All sewers shall be on continuous grade and straight alignment between manholes.

E. All sewer lines shall be designed with the entry into the manhole by the proposed sewer lines at an angle of 90° or greater to the downstream line. In the event that this is impractical, the Design Engineer must satisfy the Department that adequate losses have been provided in the hydraulic analysis as shown in Paragraph 2.2.04.G.

F. Where sewer depth is 10 feet or less, sewers and manholes shall be located a minimum of 15 feet horizontally from any part of a building, structure, or its foundation. Where the depth of sewer is greater than 10 feet, the sewers and manholes shall be located a minimum of 20 feet from any part of a building, structure, or its foundation.

G. Laterals serving more than one single-family dwelling will not be allowed.

H. Siphons are to be avoided and will only be considered on special occasions. The Design Engineer shall submit justification and calculations demonstrating the need for siphons. Siphons may only be installed with prior approval from the Department.

2.2.03 Capacity Design

A. Determine flow quantities as described in 2.2.01.1 and 2.2.01.2 above.

B. The hydraulic grade line for all conditions of flow shall be below the crown of the sewer.

C. Computations of all lines shall be shown on a form similar to the sewer design form in Appendix C, including anticipated future relief lines that may be required. Computations shall be accompanied by an Overall (System Layout) Plan. Map(s) shall show the entire drainage area involved, location(s) of line(s) in the system, and the points of entry of flows, including any flows being received from other areas. A drainage area map shall be keyed to hydraulic analysis. Computations and maps shall be submitted to the Department for approval.

2.2.04 Hydraulic Design – Sewers

A. Minimum grades shall not be less than those required to produce a velocity of three (3) feet per second when the sewer size selected is flowing full or half full. In situations where this velocity in not achievable, a minimum velocity of two and one quarter (2.25) feet per second may be acceptable with prior approval from the Department. Pipe sizes shall not be arbitrarily increased in order to take advantage of a flatter grade.

B. The minimum size pipe to be used in systems shall be eight (8) inches. Six (6) inch lines may be used under certain circumstances with prior approval from the Department.

C. Computations for velocity of flows in new pipe shall be based upon the following minimum values of "n" as used in the Manning formula for velocity of flow.

1. Ductile iron pipe sizes 8 inches through 21 inches: "n" equals 0.013

2. Ductile iron pipe sizes 24 inches and above: "n" equals 0.012

3. For PVC, “n” can be no lower than 0.010 for all sizes

D. In cases where the calculated depth of flow is less than pipe flowing full, the velocity at actual depth of flow shall be computed.

E. For sewage flow depth less than 1/4 full, an allowance shall be made for increased value of "n" and in no case shall velocities of less than 1.3 feet per second be permitted. The improved velocities shall be accomplished by steeper grades and not by changing pipe diameter.

F. Sewer services requiring service laterals of 6 inches or greater shall connect to the main at a manhole. Sewer services for residential connections shall be a minimum of 4 inches. Services shall be at an angle of 90° to the main, as practical, with the actual connection to the main at 45° in the direction of flow. Connections shall be installed at a minimum grade of ¼ inch per 1 foot.

G. Miscellaneous head losses at manholes and curves shall be computed in accordance with the following. Junctions of more than two (2) pipes will require special consideration.

1. Manholes where radius of turn is less than 2 pipe diameters:

$$H = 0.50 (\text{angle} /90°)^{.5}(V^2/2g)$$

2. Manholes where radius of turn is greater than 2 pipe diameters:

$$H = 0.25(\text{angle}/90°)^{.5}(V^2/2g)$$

Where:

angle is horizontal deflection angle
$V^2/2g$ is velocity head of effluent pipe

3. Loss for straight run manhole shall be 0.1 feet. Where this is not achievable, Design Engineer shall submit calculations and justification. In no case shall loss less than 0.05 feet be allowed.

H. Where pipe diameters increase at manholes in direction of flow, the effluent invert shall be lowered below influent elevation as follows:

Change in invert elevation equals $0.8 (D^1 - D^2)$

Where:

D^1 equals downstream diameter, feet
D^2 equals upstream diameter, feet

This adjustment shall be in addition to computed head loss.

I. Special consideration shall be given to cases where pipe diameters decrease in direction of flow. Submissions will be reviewed on a case-by-case basis and must be approved in advance by the Department.

J. In general, average flow velocities greater than ten feet per second shall not be permitted. Outside drop manholes shall be provided where required to eliminate steep slopes and to reduce high velocities to a limit of eight feet per second or less. Where it is impractical to limit velocities below eight feet per second, reasonable effort must be made not to exceed ten feet per second.

2.2.05 Structural Design and Location

A. Structural requirements must be considered in the design of all sewers and appurtenances.

B. The proper strengths shall be determined and indicated for sewer pipe materials being specified. Strength shall be based upon pipe size, proposed depth, width of trench, bedding conditions, existing ground conditions, etc. The proper strength of sewer pipe is a matter of detail design not subject to simple generalizations. Minimum bedding shall be Class C.

C. In deep cuts, it is generally preferable to change pipe strengths to obtain proper design rather than vary bedding conditions. However, pipe strength or class shall be shown on plans with stations to indicate the location. For sewer lines less than 3' deep, minimum Class 51 ductile iron (with SewperCoat or Protecto 401 lining) shall be used. For lines 3' to 10' deep, a minimum of Class 51 ductile iron (with SewperCoat or Protecto 401 lining), PVC C-900 (DR-18), or PVC C-905 (DR-26) shall be used. For sewer lines greater than 10' deep, a minimum of Class 51 ductile iron (with SewperCoat or Protecto 401 lining) or PVC (DR18) shall be used.

D. No change in pipe strength or material shall be made between manholes unless it can be substantiated that a considerable cost savings would result and the integrity of the system would not be jeopardized. Proper precautions shall be taken regarding correct location(s) of varying strength of pipe.

E. The minimum manhole diameter shall be 48-inches when the total depth is less than 12 feet. The minimum manhole diameter shall be increased to 60-inches when the total depth equals or exceeds 12 feet.

F. All pipes and manholes shall be protected against hydrogen sulfide. This shall be accomplished by the use of acid-resistant pipe (PVC or lined ductile iron) and lined manholes. The Department shall approve the materials and design for the conditions at each individual location. Current approved linings are SewperCoat and Protecto 401 for ductile iron pipe and Sikagard 62 for manholes.

G. Only ductile iron pipe coated with SewperCoat or Protecto 401 lining shall be used for the following conditions:

1. Where sewer lines enter or cross streams, estuaries, lakes or reservoirs.

2. Where sewer lines cross jurisdictional wetland areas.

3. As a carrier pipe within any bore or tunnel crossing.

4. In subdivisions where sewer lines are installed in an easement along the property line between buildable areas.

5. In easements where, in the opinion of the Department, the sanitary sewer is not accessible from a street, parking lot, or driveway.

2.2.06 Manholes

A. Standard and drop manholes shall be constructed in accordance with Standard Drawings.

B. Manholes shall be installed at the end of each line, at all grade, size, material or alignment changes; at all sewer line intersections and at a maximum interval spacing of 300 feet.

C. Flow channels shall be shaped and formed in each manhole to provide a smooth transition of flow from all inlets to the outlet. The flow line shall be formed to the crown of inlet and outlet pipes to form a "U" as shown in the Standard Details.

D. Sewer lines shall be protected from a 100-year flood by either raising manhole tops above flood plain or by the use of watertight frames and covers. Where watertight frames and covers are used, unventilated length of sewer cannot exceed 1000 feet. When feasible, manhole covers shall be no more than 30 inches above ground level. Only 316 stainless steel watertight manhole inserts shall be used.

E. Where possible in unpaved areas, manholes are to be flush with existing grade and sealed with a stainless steel watertight insert.

F. At the upstream manhole in a cul-de-sac, the maximum number of sewer connections allowed into the manhole is three (3).

G. Manholes shall not have bricked-up or partially scored openings for future sewers. Properly sealed watertight stub-outs are allowed for known future connections.

2.2.07 Depth of Sewers

A. Generally, all sewers shall be of sufficient depth to provide service to the lowest sewered elevation of structure in question, allowing proper service connection grade. The minimum cover depth for all sewer lines shall be 36 inches. Where this is not attainable, lines with less than 36 inches of cover shall be minimum Class 51 ductile iron pipe lined with SewperCoat or Protecto 401 lining.

B. The Design Engineer shall certify that all proposed sites will be served by gravity with sewer service connections installed at a slope of not less than ¼ inch per 1 foot except where the Department has granted prior approval.

C. Sanitary sewers crossing under storm sewers shall maintain a minimum separation of 12 inches. Where this separation is not possible, ductile iron pipe lined with SewperCoat or Protecto 401 lining shall be used. Concrete supports may be required for the storm sewer.

D. The tops of all sewers entering or crossing streams shall be at a sufficient depth below the bottom of the streambed to protect the sewer line. In general, three feet of suitable cover shall be provided. Less cover will be considered if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to the stream channel. Reasons for requesting less cover shall be given in the Preliminary Engineering Report. PVC DR18 or ductile iron lined with SewperCoat or Protecto 401 lining shall be used.

2.2.08 Easements

A. Easements shall be established according to the procedures in Section 6 of these Standards.

2.2.09 Protection of Water Supplies

A. Follow Virginia Department of Health Waterworks Regulations and Sewerage Regulations for separation of water mains and sewers.

B. Parallel Installation

1. Normal Conditions – Sanitary sewer or sewer manholes shall be constructed at least 10 feet horizontally from water lines whenever possible. The distance shall be measured edge-to-edge.

2. Unusual Conditions – When local conditions prevent a horizontal separation of at least 10 feet, the sewer or sewer manhole may be installed closer to a water line provided that:

   a. The bottom of the water line is at least 18 inches above the top of the sewer.
   b. Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe.

C. Crossing

1. Water lines crossing over sewers shall be laid to provide a separation as described in Paragraph 4.2.010 B.2. The following construction techniques shall be used.

   a. Sewer passing over or under water lines shall be constructed of the materials described in parallel installation, unusual conditions – Paragraph 4.2.010 B.2.
   b. Water lines passing under sewers shall, in addition, be protected by providing:

      (1) A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line.
      (2) Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the water line.
      (3) That the length of the water line segment be centered at the point of the crossings so that joints shall be equidistant and as far as possible from the sewer.

D. No water pipes shall pass through or come in contact with any part of a sewer line or sewer manhole.

City of Norfolk, Virginia
Department of Utilities

DESIGN CRITERIA
SECTION 3 – FORCE MAINS

3.1 General Requirements

Force mains are to be constructed solely for the conveyance of sanitary waste. Under no circumstances shall any roof drains, foundation drains, or surface or subsurface drains be either directly or indirectly connected to any part of the sanitary sewer system.

A detailed Preliminary Engineering Report shall be submitted to and approved by the Department prior to design. The report shall evaluate the proposed sanitary sewer service area, and shall evaluate overall effect on downstream City and HRSD facilities. The report shall fully comply with all the requirements listed herein as well as applicable Virginia Department of Health (VDH) requirements. This report shall contain a Master Utility Plan and all future phasing of the project.

All applicable federal, state, and local permits and approvals must be obtained prior to plan approval. This includes the requirement to formally obtain a construction permit through the Virginia Department of Health and the Virginia Department of Environmental Quality. If a waiver for formal permit issuance has been granted, proof of the waiver must be presented prior to plan approval.

3.2 Technical Design

3.2.01 Design Factors

A. The design of sewage pumping stations and force mains is an engineering matter and is not subject to detailed recommendations or requirements other than as required by these Standards. Each force main must be designed for the site-specific conditions and constraints.

B. Force mains shall be designed and sized to carry the maximum peak flow from the pumping station to the discharge terminus.

3.2.02 Capacity Design

A. Capacity design for the pumping station and force main shall be based on Section 2.2 of the Collection Systems Standards and Section 1.2 of the Sewage Pumping Station Standards. The capacity analysis shall take into consideration such parameters as minimum, average, and peak station inflows as well as minimum, average, and maximum pumping rates from the pumping station.

B. Every effort shall be made to maintain a full force main under all operating conditions.

C. At pumping capacity, a minimum scouring velocity of 3.0 feet per second is required. The maximum velocity is eight feet per second. Where velocities within a force main will exceed eight feet per second, a detailed explanation with calculations must be submitted to the Department for approval.

D. Force mains shall be four inches or larger in diameter. However, if a grinder pump serves the system, the Department may grant an exception.

3.2.03 System Layout

A. Force mains shall have a positive slope from the pumping station to the point of discharge unless site-specific conditions make it impractical.

B. Extra depth of bury shall be provided in lieu of air or air/vacuum relief valves wherever feasible. Every effort shall be made to maintain the force main below the hydraulic gradient. If extra depth is not feasible, manual air relief valves designed for installation on sewage force mains are to be installed at high points in the force main in an approved structure with adequate means of drainage and flushing. The riser for the air relief valve shall be copper.

3.2.04 Structural Design

A. The proper strengths shall be determined and indicated for sewer pipe materials being specified. Strength shall be based upon pipe size, proposed depth, width of trench, bedding conditions, existing ground conditions, etc. The proper strength of sewer pipe is a matter of detail design not subject to simple generalizations. Bedding shall be crushed stone or gravel aggregate conforming to VDOT No. 57 stone, or as required for the existing conditions.

B. A minimum of PVC (DR18) or Class 51 ductile iron pipe (lined with Sewpercoat or Protecto 401) with restrained joints as necessary shall be used on all force mains. HDPE may be considered on a case-by-case basis. The use of HDPE requires prior Department approval.

C. Force mains that cross VDOT and City rights-of-way shall be installed in casing pipe in accordance with VDOT Standard Drawing 1404.01. Force mains under railway tracks and across railway rights-of-way shall be installed in casing pipe in accordance with the latest edition of the American Railway Engineering and Maintenance-of-Way Association (AREMA). Additionally, the following parameters also apply:

1. Steel casing pipe shall have minimum yield strength of 35,000 p.s.i.

2. The casing pipe shall be electrically isolated from carrier pipe.
3. Casing pipe shall be sloped at a minimum grade of 1/16" per foot.
4. A 2" weep hole shall be provided at each end.

Table 3.1 indicates the minimum wall thickness allowable for casing pipe.

TABLE 3.1

MINIMUM WALL THICKNESS FOR CASING PIPE

PIPE CASING						
CARRIER PIPE DIAMETER (IN.)	MINIMUM WALL THICKNESS, inches					
	MINIMUM CASING PIPE DIAMETER (IN.)	CRITERIA WITHIN RAILROAD RIGHT-OF-WAY		CRITERIA WITHIN CITY OR VDOT RIGHT-OF-WAY		MINIMUM NUMBER OF CASING SPACER RUNNERS
		R.C.P. WITH PROTECTIVE COATING	STEEL WITH PROTECTIVE COATING	R.C.P.	STEEL	
4	12	3.0	0.375	3.0	0.250	4
6	18	3.0	0.375	3.0	0.250	4
8	18	3.0	0.375	3.0	0.250	4
10	20	3.0	0.375	3.0	0.250	4
12	24	3.5	0.375	3.5	0.250	4
16	30	4.0	0.500	4.0	0.375	6
18	30	4.0	0.500	4.0	0.375	6
20	36	4.5	0.563	4.5	0.375	6
24	42	5.0	0.625	5.0	0.500	6

D. Force mains shall be sufficiently anchored within the pump station and throughout the line length. The number of bends shall be as few as possible. Restrained joints, or tie rods shall be provided where restraint is needed. All buried tie rods shall be fabricated from Type 316 SS. Design calculations and summary table shall be submitted for proposed restraint lengths.

E. The minimum cover depth for force mains shall be 36 inches.

F. The Design Engineer shall consider ground conditions in the case of metallic pipelines and provide suitable corrosion protection where necessary.

3.2.05 Other Considerations

A. When a force main terminates into a gravity sewer system, it must enter the receiving manhole with an invert elevation that will ensure a smooth flow transition to the gravity sewer system in accordance with the HRPDC standard detail. The force main shall be designed to enter the gravity sewer

system at a point no more than one foot above the flow line of the receiving manhole using the standard saxophone connection detail.

B. Receiving manholes shall be coated with Sikagard or an approved acid resistant cementitious or epoxy coating.

C. Pressure and leakage tests shall meet or exceed the latest versions of AWWA C600 and ASTM E103 – "Standard Method for Hydrostatic Leak Testing." Under no circumstances shall the pressure in the pipe be permitted to exceed the rated pressure of the pipe. Any force main or section thereof failing the pressure test shall be removed and replaced to the satisfaction of the Department. The line must then be retested in accordance with AWWA Standards and the project specific specifications.

D. Force mains in the vicinity or crossing wetlands shall have restrained joints and fittings. Special consideration shall be given to proper structural support in these cases.

E. Non-ferrous mains shall have a detectable 10 gage insulated copper tracer wire buried in the trench 12 inches above the main with non-metallic location detection tape 12 inches above tracer wire.

City of Norfolk, Virginia
Department of Utilities

DESIGN CRITERIA
SECTION 4 – WATER MAINS

4.1 General Requirements

Water and fire protection distribution facilities are to be provided solely for the purpose of supplying potable water and fire protection. Under no circumstances shall cross-connections be allowed to unapproved water facilities. All drawings must comply with the City of Norfolk's Cross Connection Control Program. The following design parameters should be used in the design and construction of water distribution facilities. Water transmission facility design parameters are not included herein and such criteria will be established on a case-by-case basis.

A detailed Preliminary Engineering Report shall be submitted to and approved by the Department prior to design. The report shall evaluate the proposed water distribution service area, and shall evaluate overall the effect on upstream and downstream Department facilities. The report shall fully comply with all the requirements listed herein as well as applicable Virginia Department of Health (VDH) requirements. This report shall contain a Master Utility Plan and all future phasing of the project.

All applicable federal, state, and local permits and approvals must be obtained prior to plan approval. This includes the requirement to formally obtain a construction permit through the Virginia Department of Health and the Virginia Department of Environmental Quality. If a waiver for formal permit issuance has been granted, proof of the waiver must be presented prior to plan approval.

4.2 Technical Design

4.2.01 System Layout

A. The overall layout and general design shall conform to the parameters set forth in the approved Preliminary Engineering Report. In general, main line valves are required at intervals of not greater than 1000 feet and at tees and crosses to allow adequate control of the system without major system shutdowns. The Department may approve one less valve than the number of main lines at tees and crosses if the overall system allows adequate flow control. This approval is at the sole discretion of the Department and must be requested during the preliminary design phase.

B. All water mains shall be located, where practical, in:

1. Legally established road rights-of-way.

2. Legally established permanent easements for such purpose which are immediately adjacent to legally established road rights-of-way or paved areas either existing or as proposed by the Design Engineer. Easements may be used only if road rights-of-way are impractical to use.

3. Paved areas (whether in easements or in road rights-of-way).

4. Water lines installed in accordance with 4.2.01 B. 1., 2., and 3. will be within or adjacent to vehicle lanes or travel lanes. Water lines going across country where normal vehicle access makes it impractical for inspection, testing, and maintenance are not acceptable.

C. Construction shall generally be parallel to the centerline of roads or easements. The same offset shall be used throughout except when existing utilities dictate a change in offset along the proposed line.

D. Water mains sixteen (16) inches and smaller shall be installed a minimum of 10 feet from any part of any structure, building, or its foundation. Water mains larger than sixteen (16) inches shall be installed a minimum of 20 feet from any part of any structure, building, or its foundation. Water mains shall be installed a minimum of 3 feet from curbs, gutter pans, sidewalks, and similar structures.

4.2.02 System Design

A. An analysis shall be prepared that tabulates the number of people being served or proposed to be served as determined from existing zoning. The tabulation shall be by incremental areas for evaluation purposes.

B. Average, maximum day, maximum hour, and fire flows shall be developed for areas and sub-areas and tabulated in the report.

C. The design documentation shall address total current and projected future flows and system capacities of existing and proposed utilities and shall provide the proposed water main sizes. Design assumptions shall be clearly documented.

D. The design shall be based on ultimate development (complete build-out of the area) and shall present such factors as deemed necessary for a sound evaluation of the various factors used in development of the report.

E. The Design Engineer shall submit to the Department a neat and orderly set of design calculations to illustrate normal and fire flows, pipe size selection, and fire protection requirements. Where system flow information is needed, the Engineer shall consult with the Department.

F. The system shall be designed to maintain a minimum pressure of 20 psi in the distribution system at the design flow. Where the pressure at the service tap exceeds 80 psi, the provisions of the Uniform Statewide Building Code shall apply.

G. Dead-ends are not permitted and should be avoided by looping of all mains. Where dead-end lines are unavoidable, they shall be provided with a fire hydrant, flushing hydrant, or blowoff for flushing purposes. Blowoffs will only be permitted on 4-inch mains. The flushing device shall not be directly connected to any sewer.

4.2.03 Hydraulic Design

A. Water distribution systems shall be designed to provide adequate flow and pressure for both domestic supply and fire flow, based on sound hydraulic system modeling and in accordance with AWWA Manual 31.

B. Hydraulic design shall be accomplished by use of hydraulic modeling software acceptable to the Department. A Hazen-Williams coefficient of friction equal to 120 shall be used for purposes of design for new pipes. Friction coefficients for existing pipes shall be determined based on the best available information and shall be subject to the approval of the Department. If current data is not available the Department may conduct fire flow tests for the Design Engineer.

C. The maximum allowable velocity is 5 fps for domestic design and 9 fps for domestic plus fire flow.

4.2.04 Demand Design

A. Maximum rates of water consumption shall be calculated and used as a basis of hydraulic design. Average daily water consumption rate values for the number and type of consumers anticipated to be served shall be based on those contained in the Virginia Department of Health Waterworks Regulations and the latest version of the International Plumbing Code (IPC). Any such rates not given or any deviations from tabulated rates shall be estimated and justified by the Design Engineer for approval by the Department.

B. The average annual daily water consumption rates shall be adjusted by a multiplier to arrive at the maximum daily and maximum hourly water consumption rates expressed as follows:

$Q_{md.} = Q_a \times C_{md}$ $Q_{mh.} = Q_a \times C_{mh}$

Q_{md} is maximum daily water consumption rate.
Q_{mh} is maximum hourly water consumption rate.

Q_a is average annual daily water consumption rate.
C_{md} is constant varying from 1.5 to 1.75.
C_{mh} is constant varying from 2.5 to 2.75.

Q_{mh} shall be used as the basis for hydraulic design

4.2.05 Public Fire Protection

A. Rates of flow for fire protection shall be estimated based on the latest edition of the Insurance Services Office (ISO) Fire Suppression Rating Schedule, the latest edition of the National Fire Protection Association Handbook, and AWWA Manual 31, except as modified herein. A maximum allowance of 50% reduction in needed fire flow may be allowed for buildings with automatic sprinkler systems that provide full protection.

B. The minimum fire flow from any individual fire hydrant shall be 500 gpm. The minimum flowing pressure at maximum flow shall be 20 psi measured at the flowing hydrant.

C. The maximum fire flow from any individual fire hydrant shall be 1500 gpm at 40 psi. An additional hydrant shall be provided for required flows in excess of 1500 gpm.

D. During maximum rated fire flow conditions, the pressure drop in any fire protection system shall not exceed 15 psi from the point of connection at the existing City system to any fire hydrant or any combination of required hydrants.

E. The minimum size water line used for domestic water and fire protection to properties zoned agricultural or single family residential shall be six (6) inches in size. The minimum size water line used for domestic water and fire protection to properties zoned multi-family residential, commercial, or industrial shall be eight (8) inches in size.

F. The minimum sized water lines shall be looped to provide feed from at least two directions where practical. The sizing of fire service lines that are larger than the minimum sizes shall be determined by Sections 4.2.03 "Hydraulic Design". Not more than one fire hydrant shall be installed on a 6-inch dead end line.

G. Dead end lines shall not contain more than 600 feet of minimum sized pipe. Additional lengths required shall be provided by increasing the line size.

H. Fire hydrants should be located at intersections wherever possible. The location should be:

1. On the same side of the street as the main.

2. As safe from traffic as possible.

3. A minimum disruption to parking.

The location of fire hydrants shall be subject to the approval of the Department and the Norfolk Fire Department.

I. Mid block hydrants should be at property lines wherever possible. On curbed and guttered streets, hydrants shall be 18" to 24" back of the curb. Where curbs and gutters do not exist, hydrants shall be 8' to 15' from solid roadway, where possible. Outlet centers shall be a minimum of 18" above the ground or sidewalk level.

J. The break flange shall be located from 0" to 4" above ground elevation and the outlet centers shall be a minimum of 18" above ground elevation.

K. Fire hydrant spacing for properties zoned agricultural or single family residential with spaces between houses greater than 100 feet shall not exceed 500 feet or require a hose lay of over 350 feet from the hydrant to any part of any structure to be protected.

L. Fire hydrant spacing for properties zoned multi-family residential, commercial, or industrial shall not exceed 350 feet or require a hose lay of over 250 feet from the hydrant to any part of any structure to be protected. Where multiple fire hydrants are needed to supply the required fire flow, all necessary hydrants must be located within the specified hose lay.

M. No fire hydrant shall be placed closer than 50 feet from the face or overhang of any building to be protected. For commercial, industrial, and multi-family construction, fire hydrants not more than 300 feet from the protected building may be rated for not less than 1000 gpm. Fire hydrants further than 300 feet from the building to be protected shall be rated in accordance with the ISO standards.

N. The above criteria for spacing fire hydrants may be modified by the Department to improve fire hydrant accessibility for fire fighting purposes.

O. Structures fully protected by an automatic sprinkler system and directly connected to the City's water system require installation of a detector check and an appropriate backflow prevention device. Structures protected by automatic sprinkler systems and with a fire department connection (Siamese connection) require installation of a detector check, dedicated fire hydrant, and the appropriate backflow prevention device. The dedicated hydrant is not credited toward external protection requirements. Siamese connections must be located within 50 feet of a dedicated hydrant.

P. The following table is a guideline of fire flow requirements.

TABLE 4.1

FIRE FLOW CRITERIA
FOR WATER SYSTEM EVALUATION

Land Use Characteristics	Min. Fire Flow (gpm)	Fire Duration (hours)	Desired Fire Storage Volume (mg)
A. Residential			
Single Family			
Low density (over 100' between buildings)	500	2	0.06
High density (less than 100' between buildings)	1500	2	0.18
Multifamily townhouses/apartments	1500	2	0.18
B. Office/Retail			
Low density/strip	2000	2	0.24
Shopping centers	3000	3	0.54
High density office (multistory)	6000	4	1.44
C. Institutional	4000	4	0.96
D. Industrial			
Low to medium density, low to normal combustibility contents	4000	4	0.96
High density, or higher combustibility contents	8000	4	1.92

4.2.06 Structural Design

A. The proper strengths shall be determined and indicated for water pipe materials being specified. Strength shall be based upon pipe size, proposed depth, width of trench, bedding conditions, existing ground conditions, etc. The proper strength of sewer pipe is a matter of detail design not subject to simple generalizations. Bedding shall be crushed stone or gravel aggregate

conforming to VDOT No. 57 stone, or as required for the existing conditions..

B. A minimum of PVC (C900 or C905) DR18 or a minimum Class 51 ductile iron pipe shall be used on all water mains.

C. Where required, proper blocking and/or restraints must be provided and shown on the drawings. Thrust blocks will not be permitted unless joint restraints are impractical to use. Design calculations and summary table shall be submitted for proposed restraint lengths.

D. Proper support and accessibility shall be provided for aerial or suspended lines.

E. Where exposed to traffic, meter boxes and vaults shall be designed for the appropriate traffic loading.

4.2.07 Water Appurtenances

4.2.07.1 Hydrants

A. Hydrants shall be installed in accordance with the Department's standard details.

B. Where hydrant drains are not plugged, they shall be drained to the ground surface or to dry wells provided exclusively for this purpose.

C. Hydrant drains shall not be connected to sanitary sewers or storm drains.

D. Fire hydrants shall be connected only to water systems adequately designed for fire flows in addition to domestic flow.

E. Hydrants shall be spaced in accordance with Paragraph 4.2.05, Public Fire Protection.

4.2.07.2 Manual air release valves and blowoffs

A. Valves shall be provided at high points as necessary. The Design Engineer shall specify the size, but in no case smaller than 1".

B. Air relief pipe shall be below grade and be equipped with an extension fitting that extends above grade.

C. Air relief valves shall be ¼-turn, lever-operated ball valves.

D. A two-inch blowoff shall be provided at the end of all dead-end lines where fire hydrants or flushing hydrants are impractical to use.

4.2.07.3 Chambers and boxes for valves, air relief, meters, and blowoffs

A. Air and sediment accumulations may be removed through a standard fire hydrant; compressed air and pumping may be used for dewatering mains through hydrants.

B. Chambers or pits containing valves, blowoffs, meters, or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blowoffs or air relief valves be connected directly to any sewer.

C. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water or to absorption pits located above the seasonal groundwater table elevation. Sump pumps may be used where other means are not practicable.

4.2.08 Surface Water Crossings

A. Any potable water line crossing over surface water must be:

1. Adequately supported.

2. Protected from freeze damage.

3. Accessible for repair or replacement.

4. A minimum of one foot above the 100-year flood plain elevation.

B. Any potable water line crossing under a surface water must meet the following minimum requirements:

1. The pipe shall be of special construction having flexible watertight joints.

2. Valves shall be provided at both ends of the water crossing so that the section can be isolated for test or repair; the valves shall be easily accessible and not subject to flooding.

3. For the purpose of testing the section of line crossing the surface water and for locating leaks in that section, permanent sample taps shall be available at each end of the crossing and at a reasonable distance from each side of the crossing.

C. If steel casing pipe is required, it shall be sized in accordance with Paragraph 4.2.09.

4.2.09 Road and Rail Crossings

A. The Design Engineer shall coordinate any rail crossing with the appropriate rail company and obtain all required permits and approvals. Any water lines crossing VDOT right-of-way also require the Design Engineer to coordinate with VDOT and obtain all required permits and approvals. The Design Engineer is cautioned that the jurisdictional agency may require design provisions greater than what is listed herein, and it is the Design Engineer's responsibility to comply with the more stringent requirements. All water line crossings of railroads, major roadways, and other major structures shall be encased in a casing pipe. Design of railroad crossings shall comply with the requirements of American Railway Engineering Association Specifications, Part 5 – Pipelines (latest revisions). Additionally, the following parameters also apply:

1. Steel casing pipe shall have minimum yield strength of 35,000 p.s.i.

2. The casing pipe shall be electrically isolated from carrier pipe.

3. Casing pipe shall be sloped at a minimum grade of 1/16" per foot.

4. A 2" weep hole shall be provided at each end.

5. Casing pipe ends shall be sealed with bricks.

Table 4.2 indicates the minimum wall thickness allowable for casing pipe.

TABLE 4.2

MINIMUM WALL THICKNESS FOR CASING PIPE

PIPE CASING						
CARRIER PIPE DIAMETER (IN.)	MINIMUM WALL THICKNESS, inches					
	MINIMUM CASING PIPE DIAMETER (IN.)	CRITERIA WITHIN RAILROAD RIGHT-OF-WAY		CRITERIA WITHIN CITY OR VDOT RIGHT-OF-WAY		MINIMUM NUMBER OF CASING SPACER RUNNERS
		R.C.P. WITH PROTECTIVE COATING	STEEL WITH PROTECTIVE COATING	R.C.P.	STEEL	
4	12	3.0	0.375	3.0	0.250	4
6	18	3.0	0.375	3.0	0.250	4
8	18	3.0	0.375	3.0	0.250	4
10	20	3.0	0.375	3.0	0.250	4
12	24	3.5	0.375	3.5	0.250	4
16	30	4.0	0.500	4.0	0.375	6
18	30	4.0	0.500	4.0	0.375	6
20	36	4.5	0.563	4.5	0.375	6
24	42	5.0	0.625	5.0	0.500	6

4.2.010 Separation of Water and Sewer Lines

A. Follow Virginia Department of Health Waterworks Regulations and Sewerage Regulations for separation of water mains and sewer lines.

B. Parallel Installation

1. Normal Conditions – Water lines shall be constructed at least 10 feet horizontally from a storm or sanitary sewer or sewer manhole whenever possible. The distance shall be measured edge-to-edge.

2. Unusual Conditions – When local conditions prevent a horizontal separation of at least 10 feet, the water line may be laid closer to a sewer or sewer manhole provided that:

   a. The bottom of the water line is at least 18 inches above the top of the sewer.
   b. Where this vertical separation or the 10-foot horizontal separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe.

C. Crossing

1. Water lines crossing over sewers shall be laid to provide a separation as described in Paragraph 4.2.010 B.2. The following construction techniques shall be used.

   a. Sewer passing over or under water lines shall be constructed of the materials described in parallel installation, unusual conditions – Paragraph 4.2.010 B.2.
   b. Water lines passing under sewers shall, in addition, be protected by providing:

      (1) A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line.
      (2) Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the water line.
      (3) That the length of the water line segment be centered at the point of the crossings so that joints shall be equidistant and as far as possible from the sewer.

D. No water pipes shall pass through or come in contact with any part of a storm sewer line, sanitary sewer line, or sewer manhole.

4.2.011 Service Connections and Meter Requirements

A. Each service shall have an individual direct tap.

B. One water service is allowed per lot, except that duplexes can have two. Exceptions will be made for residential sprinkler services and irrigation systems where a separate metered service is allowable with prior approval from the Department.

C. Water meters shall be placed at the edge of the right-of-way centered in the lot. Avoid placement in high traffic areas and drainage swales.

D. Residential services are generally ¾" or 1" with a 5/8" meter. Design Engineer shall be responsible to design the service and meter size for actual conditions. Calculations for the size of services and meter sizes shall be performed in accordance with AWWA Manual M22, Sizing Water Service Lines and Meters, the latest edition of the International Plumbing Code, or alternate procedure approved by the Department.

E. New irrigation systems shall be metered separately. The irrigation meter shall be sized based on the demand criteria as determined by the Design Engineer.

F. Meter installations requiring a flow of 160 gpm or greater shall be reviewed and approved on a case-by-case basis by the Department following the guidance in AWWA Manual M-22.

G. For domestic services 6" or larger, a swing check valve shall be provided on the property owner side of the meter in order to prevent back pressure for testing and repair of the meter.

4.2.012 Easements

Easements shall be established according to the procedures in Section 6 of these Standards.

4.2.013 Other Considerations

A. For water lines less than 24 inches in diameter, a minimum depth of cover of 36 inches is required. For water lines 24 inches and greater, a minimum depth of cover of 42 inches is required. Additional depth shall be provided where required for thrust restraint or to clear underground obstructions.

B. The profile of water services at ditch lines shall be shown on the drawings. The water service shall be Type K copper and have a minimum cover of 24 inches at the ditch invert.

C. Where water lines are subject to extreme variations in temperature (i.e., attached to bridges or box culverts) consideration shall be given to expansion and contraction of pipe materials and the freezing of the line contents.

D. Corrosion Protection - The Design Engineer shall consider ground conditions in the case of metallic conduits and provide suitable corrosion protection where necessary. For pipe sizes greater than 24 inches, the design engineer shall consult a corrosion specialist.

E. Irrigation systems shall use the appropriate backflow devices as indicated in the City's Cross Connection Control Manual.

F. Non-ferrous mains shall have a detectable 10 gage insulated copper tracer wire buried in the trench 12 inches above the main with non-detectable warning tape 12 inches above tracer wire. The tracer wire shall be looped at each valve box.

DESIGN CRITERIA
SECTION 5 – DRAWING REQUIREMENTS

5.1 Drawing Organization And Format

5.1.01 Drawing Organization

A. Drawings shall consist of the following types of sheets arranged in the order listed:

1. Cover Sheet
2. Layout drawing with Index (if necessary).
3. Plan Drawings
4. Profile Drawings (prefer to be on same sheet with plan view)
5. Standard Drawings and Special Details
6. Erosion and Sediment Control Details/Environmental Site Assessment
7. Traffic Control (if necessary)

B. Projects consisting of only structures may not require plan and profile drawings. The Design Engineer shall consult with the Department for specifics.

5.1.02 Sheet Format

A. All construction drawings shall be 24 inch x 36 inch.

B. The cover sheet shall contain the Owner's name and project title in large, distinctive letters; a vicinity map with a north arrow drawn at a scale of 1 inch = 2,000 feet to indicate the general vicinity of the contemplated construction; and a signed and dated professional registration stamp of the design engineer or person responsible for the design.

C. The layout map shall be at a scale not less than 1 inch = 600 feet and shall show all proposed utilities with ties to existing utilities. The lines of the proposed construction, together with proposed utility structures, shall be indexed on the drawings to indicate the extent of coverage on each drawing or, in the case of structures, to the group of drawings involved.

D. Plan and profile drawings, shall show horizontal, vertical, and topographical data.

E. All drawings shall bear a suitable title showing the name of the municipality or other Owner(s) of the proposed construction.

F. Each sheet of the drawings shall show the scale in feet and a north arrow where applicable; the date, and the name of the licensed professional responsible for preparation of the drawings.

G. Each drawing shall bear the same general title identifying the overall project, a subtitle identifying the affected street(s) and shall be numbered.

H. Final drawings shall be sealed with a Virginia registered engineer's stamp, signature, and date.

I. Drafting Conventions:

1. Department Standard Symbols shall be used for all drawings. When Standard Symbols are not used, a Symbol Key shall be included on the Cover Sheet. Existing facilities shall be half tone of proposed new work.

2. Standard Symbols – Proposed and Existing Facilities: Symbols shall be as described above except that solid lines shall be used for new work. The line weight for new work shall be no lighter than 0.024 inches and no heavier than 0.031 inches. Existing facilities shall be half tone of proposed new work.

3. Text, Dimensions, and Notes: Lettering shall be consistent and clear with a minimum height of 0.10 inches. The larger size lettering shall have proportionately wider line widths.

4. Layer naming convention for AutoCad drawings shall be in accordance with the guidelines in Appendix D. Drawings required that are not in this list will be given a name following the same convention and easily discernable.

J. Drawing Standards:

1. All drawings submitted for review shall comply with the standard format and quality control requirements of the Department Standards. Drawings not meeting these criteria will not be accepted for review.

2. Drawings shall be developed using the Virginia State Plane Coordinate system.

3. Drawings shall be developed using the Esri shape file format suitable for latest version of ArcView. The Department shall be consulted prior to design to determine if any changes in software requirements are required.

4. Drawings submitted for review shall be direct blueline or blackline prints. Photocopies or telefacsimile reproductions will only be accepted for information or preliminary review purposes.

5. Drawings must be clear and legible. Text shall be open so that it is readable when drawings are reduced to half size. All drawings must be capable of producing legible second-generation prints after being reduced to half size.

6. The contrast of the printed material shall be high, with blank areas being as white as possible, and all information being as dark as practicable, while remaining clear and distinct.

7. Shading, such as on plan views for paving, shall not be used on the drawings where it will hide any information when the drawing is photocopied or scanned. Shading with a pencil or using dark film will not be acceptable. For areas that need to be identified or highlighted, stippling or cross-hatching may be used, provided no other information is hidden.

K. General Requirements:

1. Drawings shall include estimated materials quantities.

2. Horizontal scale in plan and profile drawings shall be no smaller than 1 inch = 40 feet. Vertical profile scales shall be no smaller than 1 inch = 4 feet.

3. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction, particularly water mains, sewer mains, gas mains, storm drains, utility service lines, etc. shall be shown on plan and profile drawings.

4. Benchmarks shall be set no more than 500 feet apart along the lines of construction but outside the limits of construction. Datum for elevations shown shall be based on North American Vertical Datum (NAVD) 1988.

5. Drawings shall show off-site easements required and identify Deed Book and Page Number.

6. Sewer or water lines not to be owned by the City shall be shown in plan and profile view and identified as "Private" with size and material identified, if known.

7. Design Engineer shall show appropriate Erosion and Sedimentation Control based on the latest State standards.

8. Sewer and water design drawings and specifications shall contain sufficient information in order to meet all current applicable local and State requirements.

9. All water mains and sewer lines shall be clearly shown, and profiles shall identify points where crossings occur with vertical clearance between utilities.

10. Drawings shall be of such quality and contain sufficient details so that no misunderstanding may reasonably arise as to the extent of the work to be performed, the materials to be used, the equipment to be installed, or the quality of the workmanship.

11. The exact location of any test pits taken during the design phase to locate existing utilities and pavement depths shall be shown on the plan drawings.

5.1.03 Specific Requirements for Sewage Pumping Stations

A. Drawings shall include site, elevation, and plan views that completely show the pumping station and the surrounding area that may be affected by construction.

B. The force main shall be shown from the pumping station to discharge point in plan and profile.

C. Equipment layout shall be shown in sufficient detail with specific dimensions and locations.

D. Drawings shall include the location of electrical connections and characteristics.

E. Drawings shall include applicable wiring diagrams for all equipment including motors, level controllers, and high and low level alarms

F. Utility requirements shall be shown including all tie-ins and sequencing requirements; utilities to remain, to be removed, or to be abandoned; cross-connection prevention; and appropriate protection of utilities not affected by construction.

G. All required supports and anchor bolt layout, including mounting requirements and clearances shall be shown.

H. Details shall show all blocking, pipe restraints, and relief valves.

I. All manholes shall be numbered and identified and top, influent, and effluent elevations clearly shown.

J. Backflow prevention device(s), where required, shall be clearly shown.

5.1.04 Specific Requirements for Force Mains

A. Drawings for force mains shall show pipeline stationing along pipe centerline every 100 feet, pipe size, pipe materials, bearings, direction of flow, deflection angles, grade and curve data. Plan drawings shall show all surface features impacting the construction.

B. Profiles for force mains shall show the ground line, force main profile, underground utility lines, and structures that might affect force main depth. It shall also show areas where additional depth of cover will be required, any required vertical curve data, elevations, and locations of all relief valves and appurtenances. All crossings of existing and proposed water mains shall be shown to clearly indicate vertical clearance between utilities.

C. Details conforming to the Department Standards shall be shown for all pipe joint restraints at all bends, valves, fittings and tapping sleeves.

D. Location and details of all relief valves and other appurtenances.

E. If the force main is connecting to a manhole, a detail of this connection is required.

5.1.05 Specific Requirements for Collection Systems

A. Drawings for collection systems shall show pipeline stationing along pipe centerline every 100 feet, pipe size, pipe material, bearings, direction of flow, deflection angles, grade, and distance between centerlines of manholes. Plan drawings shall show all surface features impacting the construction.

B. All manholes shall be numbered and identified and top, influent, and effluent elevations clearly shown.

C. All manhole connections shall be shown on both the plan and profile views.

D. The drawings shall indicate the following information:

1. Lowest sewered existing structure elevation.

2. Low ground corner of structure with first floor service only.

3. Ground level at building line on unoccupied parcel.

4. The street address of existing house(s) shall be shown.

5.1.06 Specific Requirements for Water Mains

A. Drawings for water mains shall show pipeline stationing along pipe centerline every 100 feet, pipe size, pipe materials, bearings, direction of flow, deflection angles, grade and curve data. Plan drawings shall show all surface features impacting the construction.

B. Profiles for water mains shall show the ground line, water main profile, underground utility lines, and structures that might affect water main construction. It shall also show areas where additional depth of cover will be required, any required vertical curve data, elevations, and locations of all relief valves and appurtenances. All crossings of existing and proposed sewer lines shall be shown to clearly indicate vertical clearance between utilities.

C. Details conforming to the Department Standards shall be shown for all pipe joint restraints at all bends, valves, fittings and tapping sleeves.

D. Valves, hydrants, and other appurtenances shall be clearly shown and located on the drawings in accordance with Department Standards.

E. Backflow prevention device(s) shall be clearly shown.

5.1.07 Record Drawings

A. The final revisions to construction drawings will be made when construction is complete. Their purpose is the recording of changes that were made during construction. After the final revisions are properly made, the drawings are considered record drawings.

B. Record drawings shall be generated by taking the Contractor's as-built drawings and any drawings, shop drawings, notes, etc., from the City's Inspectors and updating the latest version of the construction drawings. The Contractor's as-built drawings are generally checked by the City's Inspectors for completeness and accuracy.

C. When making the final revisions to a drawing, modify the drawing to reflect the changes that occurred during construction and remove all previously added revision identification symbols and records on the drawing and in the revision part of the drawing's title block. The final revision is given a revision number that is one number higher than any previous revision number. The final revision number and the date of the final revisions are placed in the revision part of the title block. The final revision should be identified by "Record Drawing Revisions" in the revision block.

D. Record drawings shall be developed to be easily integrated into the existing Department GIS system. Contact the Department for the latest software being used.

E. A table shall be developed listing all of the utility assets that were modified, upgraded or created during the course of construction. The table shall provide sufficient detail for the Department to update their Asset Management Database. Contact the Department for the proper format and software being used.

5.2 Supporting Calculations and Documentation

5.2.01 Design Information

A detailed Preliminary Engineering Report shall be submitted to and approved by the Department prior to design. The report shall evaluate the proposed sanitary sewer service area, and shall evaluate overall effect on upstream and downstream City and HRSD facilities. This report shall contain a Master Utility Plan and all future phasing of the project.

5.2.02 Permits

All applicable federal, state, and local permits and approvals must be obtained prior to plan approval. This includes the requirement to formally obtain a construction permit through the Virginia Department of Health and the Virginia Department of Environmental Quality. If a waiver for formal permit issuance has been granted, proof of the waiver must be presented prior to plan approval.

DESIGN CRITERIA
SECTION 6 – EASEMENT REQUIREMENTS

6.1 General Easement Requirements

A. Whenever possible, utilities shall be constructed within the public right-of-way. Should the construction be outside the limits of the public right-of-way, recorded water or sewer easements shall be acquired, dedicated and recorded solely for the benefit of the Department. Easement boundaries shall be so shown on the plans and specifications as "Utility Easement".

B. Easement surveys shall be made and easement plats prepared in all cases where proposed construction limits exceed the limits of public rights-of-way or properties under the ownership of the developer. These surveys shall tie the lines of proposed construction to existing property lines and property corners, where corners may identify the property. The surveyor shall exert maximum effort to tie the survey to boundaries as set forth on existing plats and in descriptions.

C. Permanent easements shall be 20 feet whenever possible. When the depth of the utility is less than 15 feet, a permanent easement of 15 feet is acceptable with prior approval from the Department.

D. All utilities shall be centered in the easement. If this is not possible, the utility shall be installed as close to the center as possible, but in no case can there be less than 5 feet of access on all sides for access to meters, hydrants, vaults, or any other utility appurtenance.

E. For those utilities constructed in the public Right-of-Way, the easement shall extend the distance outside the right-of-way necessary to provide the required easement width.

F. The water or sewer easements shall be exclusively under the discretion and control of the Department. Ingress and egress shall be available to the Department's crew at all times. No other entities are allowed to use the utility easements for installation of their utility lines without the expressed written permission of the City. All plan sheets shall clearly identify the water or sewer easement and the location of all other proposed utilities. The horizontal and vertical plans shall identify all utilities proposed to cross the water or sewer easement.

G. Installation of trees, structures, buildings, stormwater BMP's, wetlands, berms or other obstruction which prevents the proper installation, maintenance, rehabilitation, operation, inspection or removal of water or sewer facilities shall not be allowed within any permanent water or sewer easement unless approved by the Department.

H. Approval by the Department will not be given for the tract water or sewerage systems until all easements have been obtained. Easements shall be clearly delineated on final construction plans.

I. Temporary construction easements and Rights-of-Entry shall be acquired for all City construction contracts. Developers constructing facilities are not required to have construction easements where work is on the developer's property. Construction easements shall provide a minimum working width of 50 feet, including the 20-foot permanent easement, unless otherwise approved. Generally it is desirable to provide more construction easement on one side than on the other to allow room for construction traffic and material storage

J. Temporary construction easements and Rights-of-Entry are generally less formal and may not require all of the information delineated herein for permanent easements. Temporary easement agreements shall be documented. Coordinate with the Department for submission requirements applicable to each project.

6.2 Easement Submission Requirements

The Norfolk City Code provides the requirements for site plans and plat submission. The following are general guidelines that are pertinent for the easement submittals to be approved.

1. LEGAL DESCRIPTION SHEETS

   The following shall be provided:

   a. Parcel number;
   b. Project number;
   c. Project name;
   d. Identification as to permanent or temporary easement;
   e. Separate descriptions on separate sheets are required where both permanent and temporary easements are to be taken;
   f. Metes and bounds descriptions shall be clear, concise and complete with sufficient detail to positively establish from known and referenced points, monuments, lines, etc. Area of taking should be stated at end of description. No coordinates shall be included in the legal description. Areas should be given in acres;

g. Descriptions of easements from platted subdivision lots, including strips off sides of lots should include name of subdivision and recording information for the subdivision as well as adjacent properties and affected lot number(s). NOTE: These are usually small areas; therefore, area should be stated in square feet; and
h. State of Virginia registered land surveyor's seal and signature.

2. PROPERTY PLATS

The following information shall be shown on the plat:

a. Parcel number;
b. Project number;
c. Project name;
d. Permanent or temporary easement areas;
e. Total area of property out of which easement is to be taken;
f. Drawn by;
g. Directional north arrow;
h. Scale;
i. Unplatted properties: complete boundaries of property description out of which easements are to be taken, including properly identified referenced corners, points of beginning, monuments, roads, bearings, distances, etc;
j. Platted subdivisions: dimensions of lot(s) as well as the lot(s) as well as the lot number(s) and including the subdivision name and recording information;
k. Easement boundaries including referenced bearings, distances, etc., and identified as shown in legend; and
l. State of Virginia registered land surveyor's seal and signature.

6.3 Easement Submittal and Review Process

A. Applicant shall submit two copies of the easement description and sketch to the Department for review. If acceptable, the applicant shall furnish two additional copies of the description and sketch, signed by a registered land surveyor or engineer along with justification for the easement request. This request shall include the purpose of the easement, potential impacts to the property owner, and potential impacts to the project if the easement is not obtained. If not acceptable, the Department will return the documents with the required corrections noted.

B. For new developments or where easements may affect other City Agencies, additional easement descriptions and sketches may be required for review and approval by the affected agencies.

City of Norfolk Commercial Plan Review Checklist

The following is a checklist of items that must be indicated on commercial plans. The list is not an all-exhaustive list and does not take the place of the Boca National Building Code (NBC). This is a guideline indicating information commonly omitted from plans submitted for plan review. It is not a substitute for, nor does it include everything indicated on a complete set of building plans. Checking your set of plans against this list of commonly omitted items will help expedite the plan review process.

I. General:

---Two (2) sets of construction plans are required. If corrections are required, then corrections are required to be made on 2 sets of plans.

---If the project is an addition to an existing building or new construction, then 3 sets of site plans are required.

---All plans must either bear the seal of an Architect or Engineer licensed in the state of Virginia, or be signed by the individual responsible for the design including his/her occupation, and address per title 54 Code of Virginia.

---Identify each room or space for its intended use.

---Provide a complete scope of work.

---Provide a wall section to show materials used.

---Provide a legend to identify all new and existing walls.

---Identify the use group as defined by the NBC.

---Identify the construction type as defined by the NBC.

II. New Construction, Additions, and change in use and occupancy:

---The site plan must show the location of the proposed Building, the dimensions from the Building to the property line, and finished floor elevations.

---Show compliance with section 503 of the NBC for height and area limitations. Include increases allowed by sections 504 and 506 if needed.

---Show compliance with section 705.2 of the NBC for exterior wall fire resistance ratings.

---Mezzanines must comply with section 505- NBC Mezzanines shall not exceed one third of the open area below.

---All wall, floor and roof systems must comply with Table 602 for fire resistance ratings.

---Show stair and guard rail details. Rise, tread, handrail, and guardrail dimensions, including baluster spacing.

---All atriums shall have an approved fire suppression system installed within it and all connecting areas shall also be sprinklered or separated by fire separation assemblies conforming to Table 602- and section 404 of the NBC.

---All structural walls, floors columns, and roof assemblies must comply with Table 602 of the NBC for fire resistance ratings.

---All stairways, shafts, and elevator hoistways shall be enclosed in fire separation walls as required by section 710, and Table 602. The more restrictive applies.

---All corridors serving as exit access shall be enclosed in fire separation walls complying with section1011.4 - NBC.

---All egress doors shall be side hinged swinging type and shall have a minimum clear opening of not less than 32 inches. In the case of double leaf doorways, at least one leaf shall have the 32-inch clear opening. All doors shall swing in the direction of egress and two exits are required when serving an occupant load of 50 or more persons. Section 1017.3 and 1017.4, NBC.

---If more than one exit is required then exit lights are required as per section 1023 and emergency lights are required as per section 1024 of NBC.

---Dead end corridors shall not exceed 20 feet. Section 1011.2 - NBC.

---All glazing must comply with chapter 24 of the NBC. Glazing in specific hazardous locations must either be safety glazing or tempered glass complying with 2405.2.

---The Building structural design must comply with Table 1606 for live loads, and 1609 for wind loads. The minimum wind load for Norfolk, Virginia is 100 M.P.H. NBC

---All new construction must comply with Chapter 11 of NBC for accessibility.

---The plumbing fixture count must comply with the International Plumbing Code 1995, with the 1996 supplement. Section 404.

---Special Inspections shall be required as per section 1705 of NBC.

---All buildings and structures erected in areas prone to flooding shall be constructed and elevated as required by the provisions of section 3 107 of NBC.

---If the building is required to be sprinklered by section 503 because of height and area or by section 904, then so note on the plans that the building is to be fully sprinklered and note the type of sprinkler system that is to be used. NBC.

---Provide UL numbers and details for all walls, floors, roofs, stairways, shafts and other structural elements required to have a fire resistance rating.

---Provide calculations to show if a building with multiple uses is required to be separated as a mixed use or non-separated. Section 313.

---Show compliance with Table 302.1.1 for specific occupancy areas.

III. Alterations to an existing building which do not enlarge the foot print of the building. (No change in use)

---All items identified in general above apply

---Show compliance with section 1110.0 of NBC for accessibility upgrades.

---All materials used must comply with Table 606 and chapter 7 of the NBC.

---Show exit lights as per section 1023 and emergency lights as per section 1024, if more than one exit is required by section 1010.

---Provide a door schedule for all new and relocated doors.

---If walls, floors, shafts, stairways or other structural elements are required to be fire rated, then provide a UL number and a detail.

---If a building has multiple uses with in the building, provide calculations to show if the building is required to either separated or non separated. Section 313.

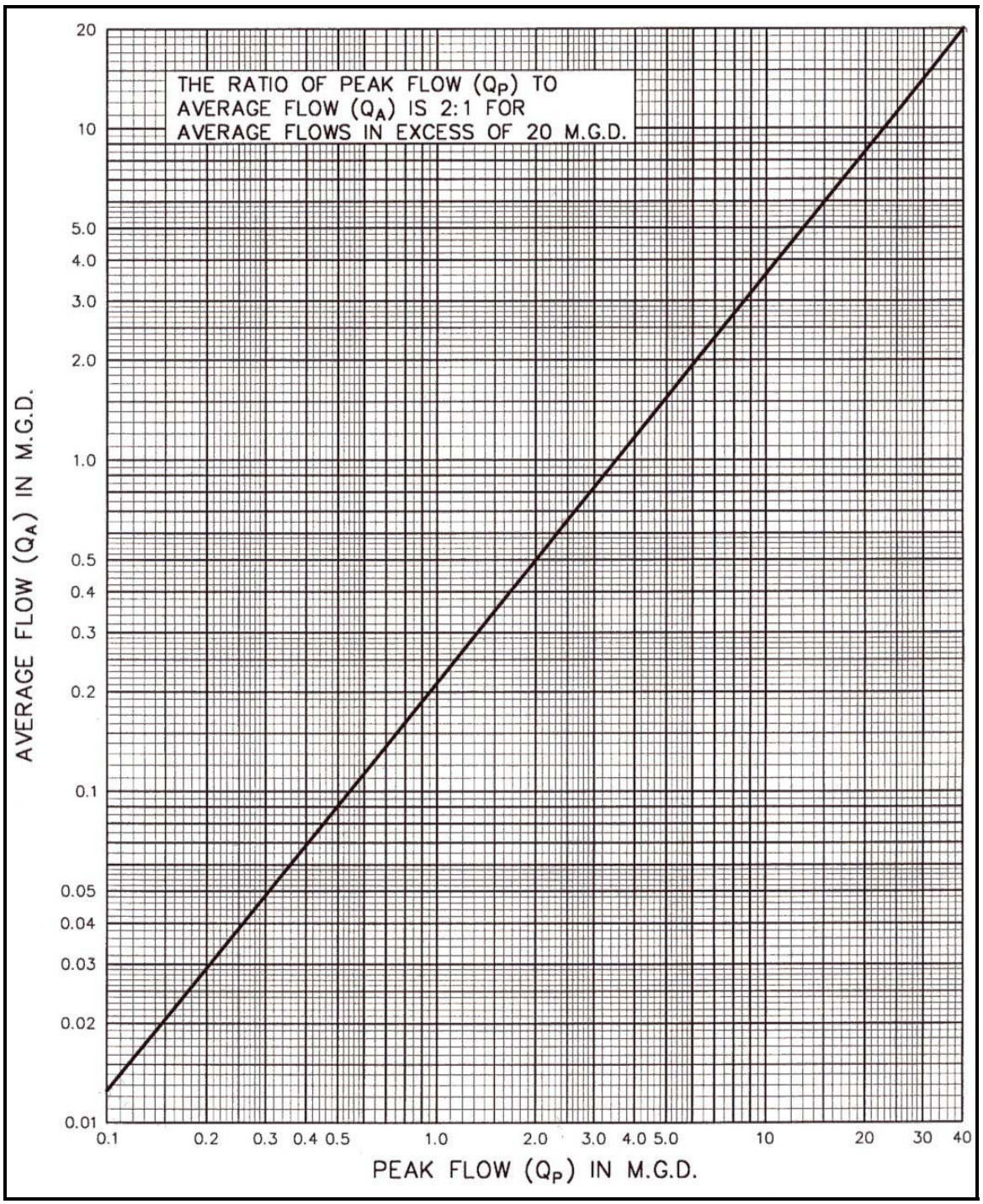
---Show compliance with table 302.1.1 for specific occupancy areas.

RE-SUBMITTAL

If plans are removed from the office for corrections, it is very important that the original permit application be returned with the corrected plans. ALL RE-SUBMITTED PLANS MUST HAVE A --PLANS CORRECTION RE-SUBMITTAL FORM -- COMPLETED TO ACCOMPANY THE REVISED PLANS.

City of Norfolk, Virginia
Department of Utilities

Relationship of Average Daily Flow to Peak Flow for Sanitary Sewer Design



DRAFT

CITY OF NORFOLK

Appendix C

DEPARTMENT OF UTILITIES

DESIGN OF SANITARY SEWERS

LOCATION	LINE NO.	MANHOLE NUMBER		AREA (ACRES)		POPULATION DENSITY PER ACRE	DOMESTIC FLOW M.G.D.			INDUSTRIAL FLOW M.G.D.		POPULATION	TOTAL FLOW MAXIMUM		LENGTH IN FEET	SLOPE%	TYPE OF PIPE	MANNING'S 'n'	DIAMETER OF PIPE	CAPACITY OF PIPE (FULL)		FUTURE RELIEF M.G.D.	FUTURE RELIEF SIZE	VELOCITY FULL (FT/SEC)	PROPORTIONAL DEPTH OF FLOW	VELOCITY (FT/SEC)	TOP OF MANHOLE AT UPPER END	GROUND ELEVATION AT UPPER END	ELEVATION AT INVERT		REMARKS
		FROM	TO	INCREMENT	TOTAL		AVG DAILY FOR YEAR	PEAK FLOW FACTOR	PEAK FLOW	AVERAGE	MAXIMUM		M.G.D.	C.F.S.						M.G.D.	C.F.S.								UPPER END	LOWER END	

City of Norfolk, Virginia
Department of Utilities

Layer Naming Protocol

This layering standard is based on the NCS (National CAD Standard) layering format. There are four defined layer name data fields: Discipline Designator, Major Group, two Minor Groups, and Status. The Discipline Designator and Major Group fields are mandatory. The Minor Group and Status fields are optional. Each data field is separated from adjacent fields by a dash ("-") for clarity.

Example: A-WALLS-INT-E is the layer for existing interior walls

Layers are selected for a given project based on the level of detail required. If differing pipe systems need to be differentiated for color or visibility, then they should be placed on different layers. If they do not need to be differentiated, then they could all be placed on the M-PIPE layer. Objects defined by layers will be drawn on that layer. For example, existing walls could be drawn on the A-WALL-E layers, whereas new walls could be drawn on the A-WALL layer.

Objects should be associated with their named layers and the layer color should determine the object color.

The following Discipline Designators are to be used:

Designator	Discipline
C	Civil
M	Mechanical
I	Instrumentation
E	Electrical
H	HVAC
P	Plumbing
S	Structural
A	Architectural

The following table is a list of layers by discipline:

Layer Name	Description
C-DFLD	Drain fields
C-DRIV	Driveways
C-DRIV-ASPH	Driveways: asphalt surface
C-DRIV-CNTR	Driveways: centerline
C-DRIV-CONC	Driveways: concrete surface
C-DRIV-GRVL	Driveways: gravel surface

Layer Name	Description
C-SIGN	Signs
C-CURB	Curb
C-MRKG	Pavement markings
C-DTCH	Ditches or washes
C-DTCH-CNTR	Ditches or washes: centerline
C-EROS	Erosion and sediment control
C-EROS-DDIV	Erosion and sediment control: drainage divides
C-EROS-SILT	Erosion and sediment control: silt fence
C-ESMT	Easements
C-FENC	Fences
C-GRAIL	Guard rail
C-HYDR	Fire protection system: hydrants and connections
C-FUEL	Fuel gas
C-FUEL-EQPM	Fuel gas: equipment (pumps, motors)
C-FUEL-PIPE	Fuel gas: piping
C-FUEL-TANK	Fuel gas: storage tanks
C-FUEL-UNDR	Fuel gas: underground piping
C-LOCN	Limits of construction
C-NGAS	Natural gas (pumps, motors, piping, and storage tanks)
C-PRKG	Parking lots
C-PRKG-ASPH	Parking lots: asphalt surface
C-PRKG-CONC	Parking lots: concrete surface
C-PRKG-GRVL	Parking lots: gravel surface
C-PRKG-SIGN	Parking lots: signs
C-POND	Ponds
C-POWR	Power
C-PROP	Property
C-PVMT	Pavement
C-RAIL	Railroad
C-RAIL-CNTR	Railroad: centerline
C-RIVR	River
C-ROAD	Roadways
C-ROAD-ASPH	Roadways: asphalt surface
C-ROAD-CNTR	Roadways: centerline
C-ROAD-CONC	Roadways: concrete surface
C-ROAD-GRVL	Roadways: gravel surface
C-ROAD-SIGN	Roadways: signs
C-RRAP	Riprap
C-SSWR-STRC	Sanitary sewer structures
C-“X”-SSWR	Sanitary sewer where X = pipe size (ex. C-12”-SSWR) includes piping
C-STEAM	Steam system
C-SD	Storm drain
C-SWLK	Sidewalks

Layer Name	Description
C-TOPO	Topography
C-TOPO-MAJR	Topography: major contours
C-TOPO-MINR	Topography: minor contours
C-SPOT	Topography: spot elevations
C-TRAIL	Trails or paths
C-WALL	Walls
C-"X"-WATR	Water supply system where X = pipe size (ex. C-12"-SSWR) includes piping
C-WATR-STRC	Water supply systems: structures
C-WETL	Wetlands
M-EQUIP	Mechanical Equipment
M-PIPE	Pipe, Valves, Fittings
M-PIPE-SL	Single Line Piping
M-item-HIDE	Hidden mechanical line work
M-item-HATCH	Mechanical, Hatch Patterns
M-item-PAD	Concrete equipment pads
M-OUTLINE	Outline of mechanical equipment for use by other disciplines
M-NOTE	General Text and Notes
M-DIM	Dimension Lines, Witness Lines
M-INFO	Transfer Information ONLY
I-PROCESS-MAIN	P&I Main Process Lines
I-PROCESS-AUX	P&I Auxiliary Process Lines
I-SIGNAL-ELECT	Electrical/Electronic Signals
I-SIGNAL	Non-Electric Signal Lines
I-DATALINK	Data link Lines
I-PCLAN	Personal Computer LAN
I-INST	Instrument Bubbles
I-SYMBOL	Non-Instrument Symbols
I-PANEL	Line work for Panels
I-SCHEDULE	Line work for Schedules
I-GRAPHIC	Background Equipment/Structures
I-NUMBER	Instrumentation and Equipment Numbers
I-COND	Conduits containing signal wires
I-NOTE	General Text and Notes
I-LDR	Leader Lines, Flow Arrows, Directional Arrows
I-DIM	Dimension Lines, Witness Lines
I-INFO	Transfer Information ONLY
E-LIGHT	Light Fixtures
E-MTR	Motors
E-PANEL	Control Panels & Consoles
E-EQUIP	Electrical equipment & items not included in above layers.
E-COND	Conduit Runs
E-COND-CONC	Embedded Conduit Runs
E-GND	Grounding wires, grids, etc.

Layer Name	Description
E-OUTLINE	Outline of electrical equipment for use by other facilities.
E-NOTE	General Text and Notes
E-LDR	Leader Lines, Flow Arrows, Directional Arrows
E-DIM	Dimension Lines, Witness Lines
E-INFO	Transfer Information ONLY
H-EQUIP	Primary HVAC Equipment
H-EQUIP-SEC	Secondary HVAC Equipment
H-DUCT	HVAC Ductwork
H-DUCT-S	Supply Ductwork
H-DUCT-R	Return Ductwork
H-DUCT-E	Exhaust Ductwork
H-HWS	Hot Water Supply
H-HWR	Hot Water Return
H-MOTOR	Motors
H-COILPULL	Coil Pull Space Requirements
H-VENT	HVAC Vents, Roof, etc.
H-PIPE	HVAC Related Piping
H-PIPE-FUEL	Fuel Oil Piping
H-PIPE DG	Digester Gas Piping
H-PIPE-COND	Condensate Piping
H-VALVE	Valves
H-PUMP	Pumps, Water Heaters & Tanks
H-OUTLINE	Outline of HVAC equipment for use by other disciplines
H-NOTE	General Text and Notes
H-LDR	Leader Lines, Flow Arrows, Directional Arrows
H-DIM	Dimension Lines, Witness Lines
H-INFO	Transfer Information ONLY
P-HW	Hot Water Lines
P-CW	Cold Water Lines
P-HWC	Hot Water Circulating Lines
P-DRAIN	General Drains
P-DRAIN-ROOF	Roof Drains
P-DRAIN-SAN	Sanitary Drains
P-EQUIP	Water Heaters, Tanks, etc.
P-FIXT	Plumbing Fixtures
P-AIR	Air Line
P-GAS	Gas Supply
P-VENT	Sanitary Vents
P-OUTLINE	Outline of plumbing equipment for use by other disciplines
P-LDR	Leader Lines, Flow Arrows, Directional Arrows
P-DIM	Dimension Lines, Witness Lines
P-INFO	Transfer Information ONLY
S-REBAR	Structural Rebar
S-CONC	Line work for concrete cut in plan or section

Layer Name	Description
S-CONC-SLOPE	Lines delineating drainage slopes of slabs
S-CONC-BACK	Line work for concrete items not affected by the cutting plane.
S-WALL-MASON	Bearing masonry walls.
S-COL	Columns, concrete unless appended
S-BEAM	Beams, concrete unless appended
S-PILE	Piles
S-STEEL	Line work for structural steel & other structural shapes
S-STEEL-EMBED	Structural steel beams embedded in or behind concrete
S-EXPIT	Expansion & Construction Joints, Etc.
S-CJ	Construction & Control Joints
S-STAIR	Stairs, Walkways, Ramps
S-OPEN	'X' lines to denote openings for Stairwells, Elevators, etc.
S-FPRINT	Footprint of Structure
S-BL	Building Limit Line
S-LDR	Leader Lines, Flow Arrows, Direction Arrows
S-DIM	Dimension Lines, Witness Lines
S-BRKLN	Break lines
S-INFO	Transfer Information ONLY